(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 634 738 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **94304674.8**

(51) Int. Cl.[6] : **G10H 1/00**

(22) Date of filing : **27.06.94**

(30) Priority : **14.07.93 US 92313**

(43) Date of publication of application :
18.01.95 Bulletin 95/03

(84) Designated Contracting States :
DE FR GB

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(54) Interface apparatus.

(57) A MIDI/joystick interface apparatus is described which incorporates a shielded connector, a shielded cable, and a terminal block including a circuit board with an extensive ground plane surrounding the joystick connections and shielding the MIDI circuitry on at least three sides. The terminal block is a housing which acts as a radiation shield. The housing or terminal block may be made of an injected molded plastic material containing electrically conductive strands of metal or the housing may be plated or painted on its interior surfaces with an electrically conductive material to form a shielding layer which may then be further connected to the ground plane of the electronic circuit board contained within the terminal block housing. The terminal block provides connectors for MIDI-In, MIDI-Out MIDI-Thru and a pair of joystick interface connectors which allows the capability to connect both MIDI devices and two joysticks to the audio adapter card simultaneously.

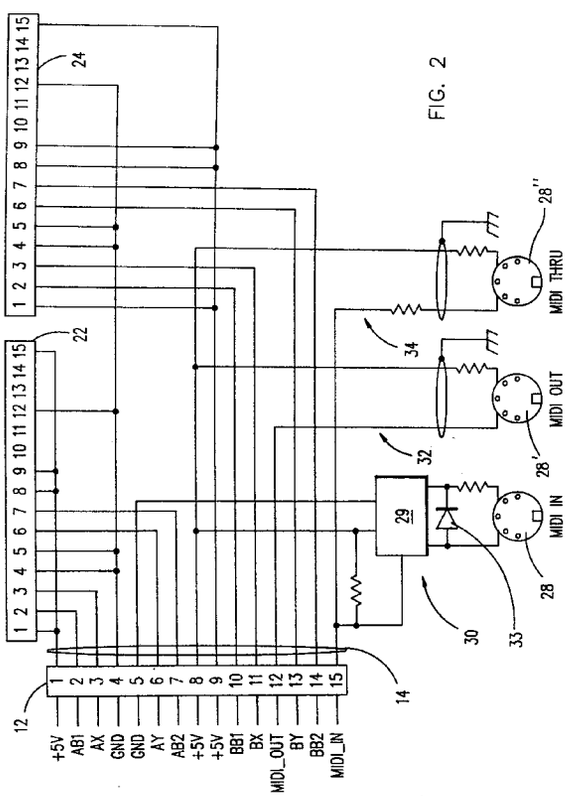


FIG. 2

EP 0 634 738 A1

This invention relates to interface apparatus for the connecting of MIDI devices and at least one joystick to a computer.

The need to interface a computer with a multitude of various external audio devices has increased dramatically with the advent of computer based audio products. These computer based audio products include a wide range of applications which can be further divided into several distinct categories, such as entertainment audio i.e., games and animation; educational audio, i.e., reading and writing tutors; training audio for use in commercial training programs; and, merchandising audio for presentations and sales.

The primary use of audio adapters to date occurs in the category of entertainment audio with computer game audio capturing the largest market share by far. Audio products in the computer based games market include SoundBlaster (TM) computer audio adapters, available from Creative Labs, Inc., of Milpitas, California. Other audio adapter cards are available from Mediavision of Fremont, California.

As the different types of connections to audio adapter cards, including interfaces for microphones, headphones, Musical Instrument Device Interface (MIDI) devices, CD-ROM drives, joysticks, etc., multiply in number, interface connections are constrained by the very limited mechanical space available for external device connectors on the back of IBM PC compatible computer adapter cards.

The industry has turned to external breakout cables to overcome this very limited space constraint. Generally, external interface apparatus comprise one computer audio adapter card which have an external rear connector of high pin density and low mechanical profile. A corresponding high pin density external connector attached to a multi-conductor cable plugs into the rear external computer audio adapter connector. The multi-conductor cable fans out the different electrical signals into several discrete and distinct industry standard connectors.

One very common computer game audio adapter card rear connector definition comprises a 15 pin D-Shell which is the mechanical and electrical standard for both MIDI and game joysticks. Although many manufacturers offer breakout cables for this connector, these breakout cables have several common shortcomings.

One shortcoming is the cost associated with the hardware needed to meet a published interface specification for the MIDI 1.0 specification and the IBM PC Game Port Specification.

Another shortcoming is the failure to comply with emissions regulations as prescribed by the Federal Communications Commission (FCC) Class B for electronic products used in the household. Many, if not most, computer game audio card manufacturers circumvent the requirement for the FCC Class B regulation. Computer game audio adapter manufacturers provide assembly schematics for their respective breakout cables directly to the consumer. The consumer is expected to assemble his own cable; because it is constructed by the consumer for personal use, the FCC Class regulation does not apply.

A further shortcoming of currently available breakout cables is the need for additional breakout connectors to support a dual joystick operation for use with compatible games having musical outputs.

Still another shortcoming of currently available breakout cables is the need for additional hardware to support not only a MIDI-In and a MIDI-Out interface, but also a MIDI-Thru interface.

Accordingly, the present invention provides apparatus for connecting computer audio adapters to MIDI compatible devices and joystick devices, said apparatus comprising: a MIDI-In connector; a MIDI-Out connector; a MIDI-Thru connector; at least one joystick connector; a first connector for MIDI interface signals and joystick signals; and a shielded multi-conductor cable for carrying said MIDI interface signals and said joystick signals, said cable having a first end and second end, said first end attached to said first connector.

Accordingly, it is an object of the present invention to provide a low cost computer audio adapter interface apparatus that supports both game port interfaces for joysticks and MIDI connections.

An embodiment provides a computer audio adapter interface apparatus that complies with the FCC Class B requirements.

A further embodiment provides a computer audio adapter interface apparatus that facilitates the connection of multiple joysticks.

A still further embodiment provides a computer audio adapter interface apparatus that facilitates the connection of MIDI-In, MIDI-Out and MIDI-Thru devices.

An embodiment of the present invention will now be described with reference to the accompanying drawings in which:

FIG. 1 illustrates the computer audio/joystick and MIDI interface apparatus.

FIG. 2 is a circuit diagram illustrating the electrical circuits contained within the interface apparatus, together with cable and joystick interfaces.

FIG. 3 is a representation of the circuit board and circuitry contained on said electronic circuit board of the interface apparatus.

FIG. 4 is a partial exploded view of the interface apparatus and its components.

Referring to FIG. 1, the breakout apparatus 10 is illustrated. The breakout apparatus 10 comprises a high pin density shielded fifteen pin connector 21 referred to commonly in the industry as a fifteen pin D connector. Connector 21 is selected to be compatible with a high pin density D socket located on an audio adapter card (not shown) installed in, for example, a

computer. Such audio adapter cards are available from Mediavision of Fremont, California or from Creative Labs of Milpitas, California. Both audio adapter cards embody, with minor alteration, the IBM P.C. Game Port Specification. The alterations eliminate a redundant +5 volt line on pin twelve, as well as a redundant ground connection on pin fifteen of connector 21 and the substitution of a MIDI-In and a MIDI-Out signal on pins fifteen and twelve, respectively. Shielded connector 21 is joined to shielded cable 14 which carries fifteen conductors 46 as shown in FIG. 3, and a foil wrapping and/or copper braid 48 which extends around and 48 provides shielding to the conductors 46. Cable 14 is passed into the terminal block 16 and the conductors 46 of cable 14 and the shielding foil or braid 48 are connected to the internal connection points on circuit board 20 and the ground plane 31 of circuit board 20 illustrated in FIG. 3.

Circuit board 30 of FIG. 3 is similarly connected to joystick interface connection sockets 22, 24 for the attachment of a pair of joysticks (not shown). Further, circuit board 20 is connected to three connectors 28, 28' and 28" which provide the plugging capability for MIDI devices such as keyboards or headphones to be connected to the cable assembly 10. The connectors 28, 28', 28" respectively provide signals referred to as MIDI-In, MIDI-Out and MIDI-Thru. The MIDI 1.0 specification, published by International MIDI Association, is embodied in the wiring of the connectors 28, 28' and 28" and through the circuit board 20, MIDI circuitry 26 as seen in FIG. 3.

Referring to FIG. 2, two joystick interface connectors 22, 24 are schematically illustrated. The connectors 22, 24 are connected to connector 21. The signals on connector 21 are identified as follows: +5 volts is the regulated 5 volt operating voltage supplied to the joystick interfaces 22, 24 on pins one and nine and to the MIDI circuits 30, 32, 34 on pin eight. The AB1 signal on pin two is the signal from the A joystick, button 1, while the AX signal is the voltage representing the X component of movement of joystick A and is present on pin three. Ground is provided to the two joysticks interfaces 22, 24 on pin four and to the MIDI-In circuit 30 by pin five. The AY signal on pin six is a varying voltage representing the Y component of movement of joystick A.

Continuing in connector 21, AB2 on pin seven is the signal from the A joystick, button 2. Similarly, the BB1 signal on pin ten and BB2 signal on pin fourteen represent the signals from buttons 1 and 2, respectively, of joystick B. The signals BX present on pin eleven and BY found on pin thirteen are the variable voltage signals representing the movement of the B joystick in the X and Y directions, respectively.

Additionally on connector 21, the MIDI-In circuitry 30 and MIDI-Thru circuitry 34 are connected to pin fifteen of connector 21 while the MIDI-Out signals from the MIDI-Out circuitry 32 are present on pin twelve. The MIDI-In circuitry comprises an opto-isolator 29 and a diode 33 to avoid ground loops and subsequent data errors in the transmitting circuitry (for example, a keyboard) and receiver circuitry (computer) are internally separated by an opto-isolator 29 such as a Hewlett Packard 6N139 opto-isolator module. The opto-isolator 29 is a light emitting diode and photo sensor in a single package. The diode 33 provides further overflow protection between the MIDI-In connector 28 and the computer to which the interface apparatus assembly 10 is attached. The circuit of FIG. 2 is a physical embodiment of the IBM P.C. Game Port Specification and MIDI 1.0 specification with the signals on connector pins twelve, and fifteen altered from the IBM P.C. Game Port Specification to accommodate the MIDI 1.0 specification requirements.

An essential aspect of the interface apparatus device 10 is compliance with the Federal Communications Commission Class B Emissions Standards. The interface apparatus circuit board 20 is provided with a substantial ground plane 31 on the circuit board 20 surface or within the board 20.

The terminal block 16 and circuit board 20 are provided with three identical connectors 28, 28' and 28" for the MIDI connections. The MIDI-In connectors 28 provide ports for attaching devices such as electronic keyboards or CD-ROM players. The MIDI-Out connector 28' will accommodate the attachment of devices such as headphones or speaker which receive and utilize the MIDI signal from the audio adapter card (not shown) to generate audio and musical output. The MIDI-Thru connector 28" is provided to permit the connection of additional MIDI devices which are capable of providing MIDI signals to the computer. The addition of the MIDI-Thru connector 28" and associated circuitry 34 permits the connection of additional MIDI devices and does not limit the number of MIDI devices which may be connected to the computer, as some MIDI interface devices do, where they only contain connectors which are comparable to the MIDI-In connector 28 and MIDI-Out connector 28'.

Referring to figure 3, the ground plane 31 of circuit board 20 completely surrounds the circuitry 25 connecting the circuit lands 27 of circuit board 20 to the connectors 22, 24. The circuit tracks 40 of circuit board 20 are laid out only to include turns which are not sharp 90 angle turns in order to minimize the radio frequency interference (RFI) or electromagnetic interference (EMI) which tend to leak more readily from the sharp 90 turns in the pattern of circuit lands 40. The MIDI circuitry 26 for the MIDI-In, MIDI-Out and MIDI-Thru functions is substantially surrounded on at least three sides of the circuitry layout 26. The ideal condition would be to completely surround the circuitry 26. However, judicious placement of the ground plane 31 around the circuitry 26 on three sides signif-

icantly reduces radiated emissions.

As can be seen in figure 3, the shielding layout of the ground plane 31 is designed so that all corners forming right angles are altered whereby the transition around the right angles is either radiused or the transition is made through at least two corners, but at angles other than 90 .

As observable in figure 3, the ground plane 31 completely separates the MIDI circuitry 26 and the circuitry 25 connecting the circuit lands 27 of circuit board 20 to the joystick interface connectors 22, 24, thereby reducing electrical crosstalk between the joystick interfaces 22, 24 and the MIDI circuitry 26.

The circuit board 20 is connected to individual conductors 46 within cable 14. Only two conductors 46, along with shielding foil 48 are illustrated in FIG. 3, but others are connected to the appropriate contacts for the MIDI circuitry 26 and joystick connectors 22, 24 as defined by the circuit diagram in FIG. 2.

The entire circuit board 20 and the termination points 27 of the individual conductors 46 and shielding foil or braid 48 as illustrated in FIG. 3 are contained within terminal block 16 as seen in FIG. 1. Referring to figure 4, terminal block 16 comprises a pair of shells 17, 19 when closed which will enclose all of the circuit board 20, the end of cable 14, and connectors 22, 24, 28, 28' and 28". This leaves only the interface portion of the connectors exposed. Connectors 22, 24 protrude from the enclosure of block 16 to permit mating with the shielded connectors on the joystick assemblies (not shown). Connectors 28, 28', 28" are disposed so that the plugging faces thereof are flush with the exterior of terminal block 16.

To further suppress the RFI and EMI radiation, the terminal block shells 17, 19 are fabricated of injected molded plastic. The plastic may be loaded with metal fibres or strands. The strands or fibres of metal touch each other and form a random grounding and shielding network of conductors which act to shield against the emission of the RFI. Alternatively, the plastic shells 17, 19 may be painted or plated with conductive material on the interior surfaces 62 thereof as viewable in FIG. 4. A metal container may be substituted for the plastic shells 17, 19.

Still referring to figure 4, elements of the terminal block 16 are illustrated in an exploded view to provide a better understanding of the grounding of shells 17, 19. Terminal block 16 is electrically connected to the ground plane 31 of circuit board 20 by the use of screws 54. Each shell 17, 19 having been molded of metal strand impregnated plastics or alternatively coated on the interior with electrically conductive paint or plated on the interior 62 surface thereof, are formed with hollow standoffs 64, 60. The inside diameter of standoffs 60 is such as to permit the passage of screw 54 or to engage the threads 58 of screw 54.

Positioned between the head of screw 54 and shell 19 is star washer 52 which acts to cut into the plastic and to simultaneously engage both the metal strands and the head of screw 54. Further, star washer 53 is disposed between shell 17 and ground plane 31 of circuit board 20, specifically, between board 20 and the standoff 64 in shell 17. Star washer 53 establishes reliable electrical contact between the shells 17, 19 and circuit board 20. Screw 54 passes through hole 50 in circuit board 20.

Since the shells 17 and 19 enclose circuit board 20 at the unshielded region of board 20, near one side of the MIDI circuitry 26, radiation emitted from the circuit board 20 at that region is trapped by the shells 17 and 19 of the enclosure or terminal block 16. Once trapped by the electrically conductive material either in or on the interior 62 of shells 17 and 19, the radiation is then conducted to and grounded onto the ground plane 31 of circuit board 20.

The effective shielding of the printed circuit board 20, together with the individual conductors 46 of cable 14, is important because the complete apparatus 10 must comply with the Federal Communications Commission Class B Standards for radiation emissions. It is extremely important to suppress the RFI over a broad spectrum of frequencies. As the audio adapter boards sold by various manufacturers may be used on a variety of computers with a variety of operational speeds or clock frequencies built into the computers, it is important that the shielding approach be effective to suppress RFI over a broad spectrum of RFI frequencies. A typical computer will include a system clock, video clock, bus clock, and possibly adapter board clocks, each operating at different frequencies. These various clock frequencies result in a very broad spectrum of radio frequency interference which must be captured and contained by the shielding of the MIDI/joystick interface apparatus. The suppression of RFI over a broad spectrum of frequencies permits the MIDI/joystick interface apparatus to be successfully attached to a broad array of computers, any of which may be provided with an audio adapter board, and to meet the Federal Communications Commission Class B standards for radiated emissions.

As one of skill in the art will appreciate, the clock frequencies generated on the conductors within a computer will tend to radiate throughout the computer and will be contained by the shielding inherent in the structure of the computer. However, when unshielded devices are attached at the interface ports of the computer or at the interface ports of adapter boards attached to the computer, the clock frequencies will propagate through the connectors to the unshielded attachments and thereby be radiated much like signals being radiated by an antenna.

With the invention described herein, the propagation of the clock frequencies into the cabling and terminal block of the MIDI/joystick interface apparatus will be shielded and suppressed to the extent neces-

sary to insure compliance with the Federal Communications Commission Class B Emitted Radiation Standards.

Claims

1. Apparatus for connecting computer audio adapters to MIDI compatible devices and joystick devices, said apparatus comprising:
   a MIDI-In connector;
   a MIDI-Out connector;
   a MIDI-Thru connector;
   at least one joystick connector; and
   a shielded multi-conductor cable for carrying MIDI interface signals and joystick signals, said cable having a first end and a second end, said first end attached to a first connector for said MIDI interface signals and said joystick signals.

2. Apparatus as claimed in claim 1 further comprising:
   a circuit board having a ground plane therethrough, said circuit board affixed at affixation points to said MIDI-In connector, said MIDI-Out connector, said MIDI-Thru connector, said at least one joystick connector and said second end of said multi-conductor cable.

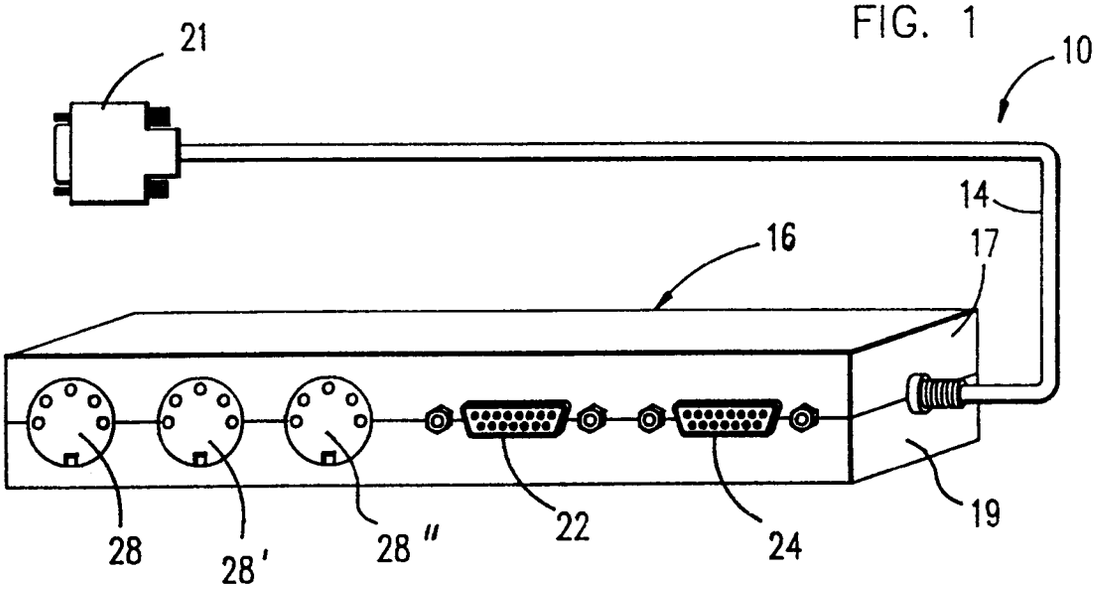
3. Apparatus as claimed in claim 2, wherein said ground plane completely circumscribes said affixation points at which said at least one joystick connector affixed to said circuit board.

4. Apparatus as claimed in either of claim 2 or 3, wherein a portion of said ground plane is disposed between said affixation points for said at least one joystick connector and affixation points for said MIDI connectors on said circuit board.

5. Apparatus as claimed in any of claims 2, 3 or 4 further comprising:
   an isolation circuit disposed on said circuit board for electrically isolating said MIDI-In connector from said multi-conductor cable; and
   an enclosure, enclosing said circuit board, having shielding properties for shielding electrical emissions.

6. Apparatus as claimed in any preceding claim wherein said first connector has two redundant pins and said redundant pins are used for all of said MIDI interface signals.

FIG. 1



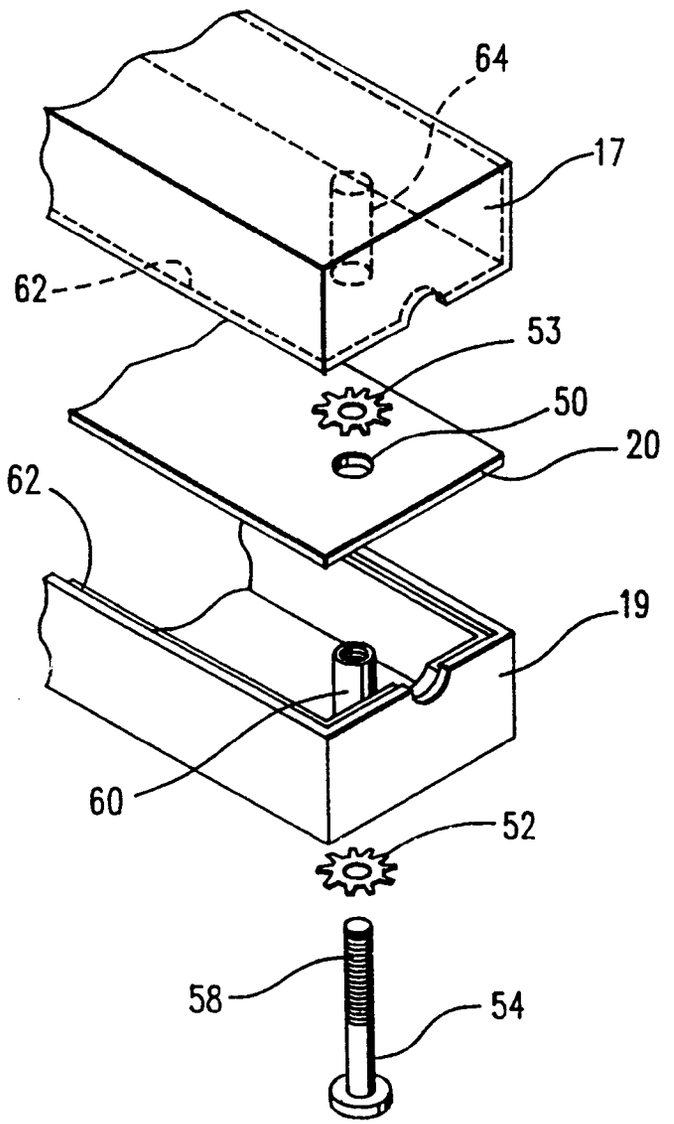


FIG. 4

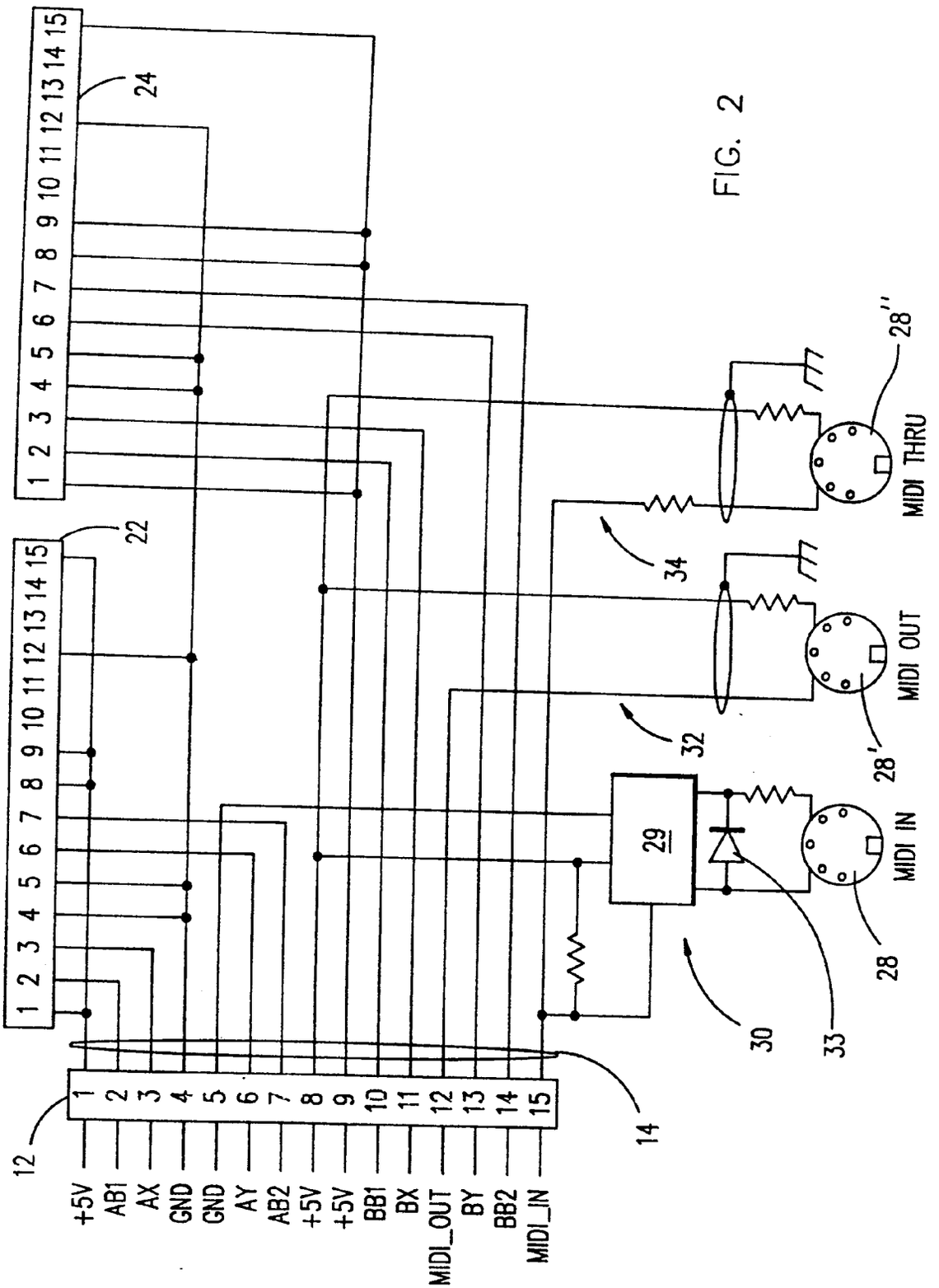

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
24
22
12
14
+5V
AB1
AX
GND
GND
AY
AB2
+5V
+5V
BB1
BX
MIDI_OUT
BY
BB2
MIDI_IN
29
30
32
33
34
28
28'
28''
MIDI IN
MIDI OUT
MIDI THRU

FIG. 2

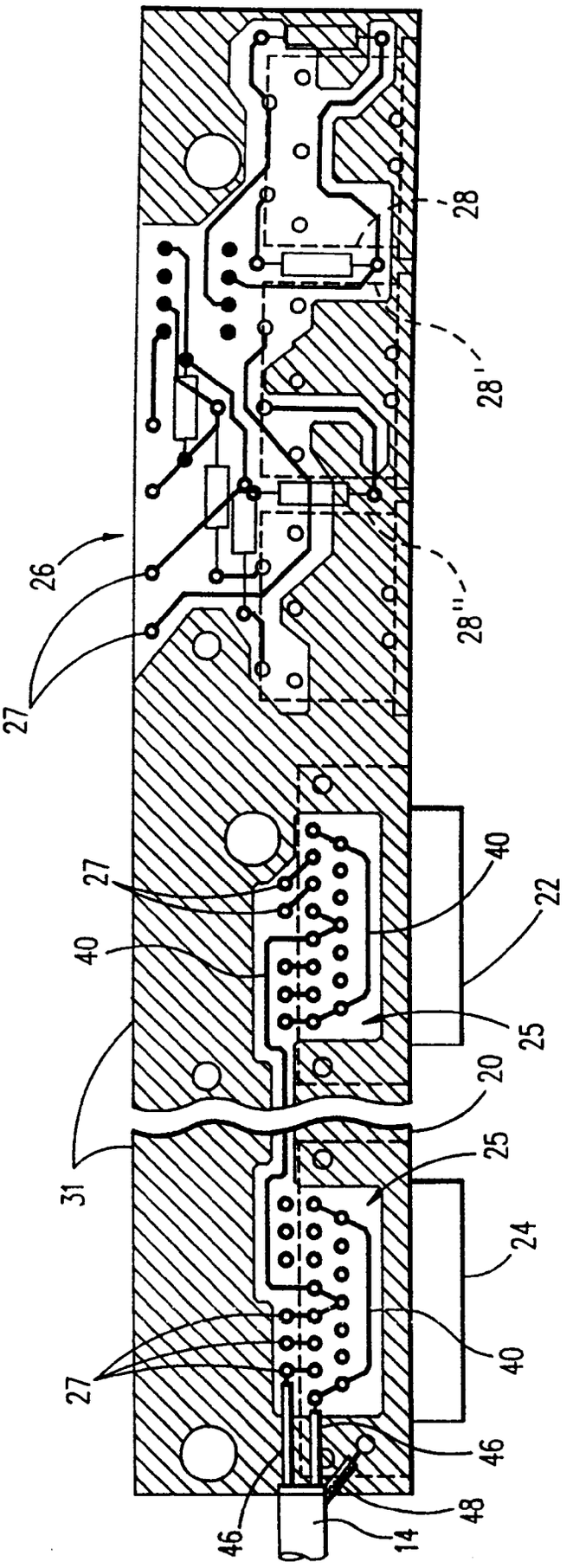


FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 4674

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	CHIP, no.8, August 1992, WURZBURG pages 250 - 251, XP000327570 O. KLUGE 'Selbst ist der Musiker: MIDI-Interface' * the whole document * ---	1,2,5,6	G10H1/00
A	US-A-5 121 491 (SLOAN ET AL.) * column 2, line 23 - column 3, line 3; figure 1 * ---	1	
A	DE-U-93 02 483 (DAHMEN) * page 3, line 22 - page 4, line 10; figure 1 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) G10H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 October 1994	Pulluard, R

CATEGORY OF CITED DOCUMENTS

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